

### Concrete Tester

The Concrete Tester, developed by the Nitto Construction Company of Hokkaido, Japan, a civil engineering contractor, enables a worker to assess a concrete structures' inner compressive strength and detect its surface deterioration and delamination by lightly hitting the surface of the concrete with a hammer type inspection device. This very economical inspection device can record precise data and has much higher measurement accuracy than the conventional Schmidt test hammer (rebound hammer) method. The inspection device correctly detects dangerous points of a concrete structure, allowing workers to accurately repair damaged sections.

The device, carried and operated by a worker, consists of the special hammer and a palm sized data recorder/readout connected by a short cable. A worker can inspect any concrete surface he can reach with a hammer blow perpendicular to the surface, regardless of its orientation. An accelerometer inside the hammer measures the acceleration at the point of hammer and concrete contact throughout each hammer blow and recovery rebound, which the recorder stores on its memory card or exports it via a USB connection. Once data are transferred to a PC, the computer calculates the forces between hammer and concrete throughout each blow and rebound, and automatically analyzes the impact waveform. It can show concrete condition on a contour map on its screen in color. The Concrete Tester estimates a surface deterioration value based on the velocity when the hammer initially contacts the concrete, measured against the velocity of the rebound. A delamination indication value is calculated based on the existence of several local peaks on the impact waveform. It requires no polishing of the testing surface and causes no damage to the concrete surface.

The Concrete Tester is used by consulting companies, maintenance and repair companies and public agencies such as the Ministry of Land, Infrastructure, Transport and Tourism, the Ministry of Agriculture, Forestry and Fisheries, and the Hokkaido government. Research by public agencies confirmed that the new inspection device had much higher accuracy and was much more economical than the test hammer method, which reinforces the high credibility of this device. Of the first 240 devices sold, 115 were sold to users in Hokkaido.

The Concrete Tester was developed by Hajime Kubo, President of Nitto Construction and Kunio Gokudan, then at Tokai University. The first Concrete Tester, the CT-02 was unveiled in 2005. The current CTS-02v4 Concrete Tester and Surveyor from Nitto Construction Co. Ltd. measures high strength concrete (up to 150N/mm<sup>2</sup>), regardless of concrete condition.

Accompanying figures show the waveform of impact force when hammering the concrete. The waveform is measured by the built-in sensor, and can be divided into two sections. The first section of the waveform up to the peak shows the time the hammer is pushing onto the concrete surface. Maximum displacement of the concrete surface occurs at the peak of the graph, when the impact force reaches its maximum value. The second section of the waveform past the peak shows the time when the displacement of concrete surface comes back to the origin. This rebound process happens through the elastic deformation energy of the concrete pushing back on the hammer. Reviewing the impact waveform in the second section, the mechanical impedance of hammer contact as the elasticity index of the concrete is measured and the strength of the concrete can be estimated from the impedance value with no damage to the concrete surface. This analysis is patent 3691477.

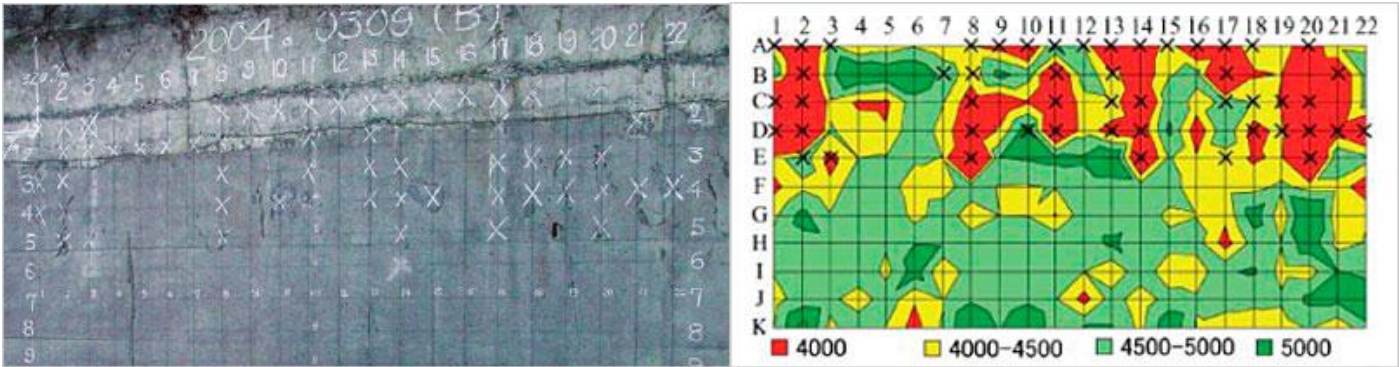
#### Concrete Tester Applications:

- Construction Site Testing - inspecting fresh concrete to ensure it meets requirements
- Periodic maintenance of concrete structures to monitor and prevent structural failure
- Quality assurance testing of concrete structures to verify previous results
- Inspections and evaluations of concrete structures and compliance with regulations and building codes
- Inspecting bridges and other concrete structures where core sampling is difficult
- Determining the strength of an entire area of concrete (using Area Mode setting)
- Inspecting defects in concrete products
- Inspecting fire damage in concrete structures by measuring strength in different locations

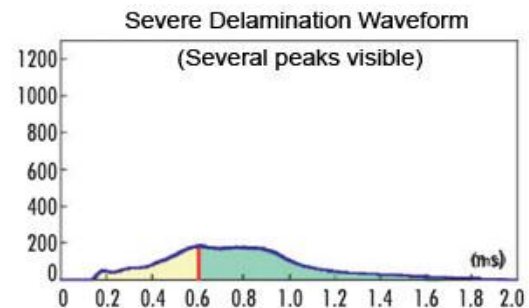
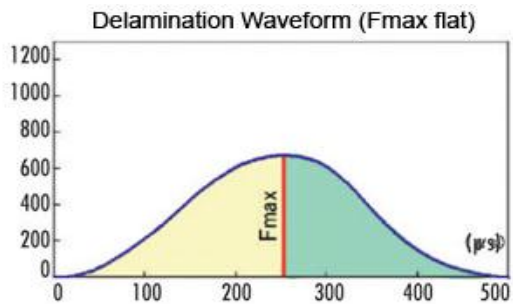
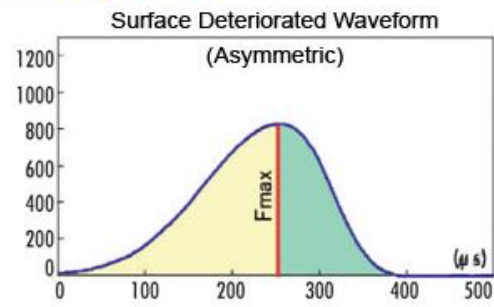
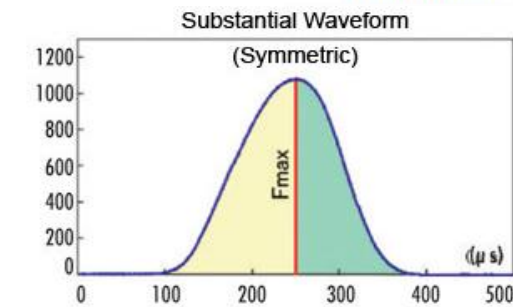
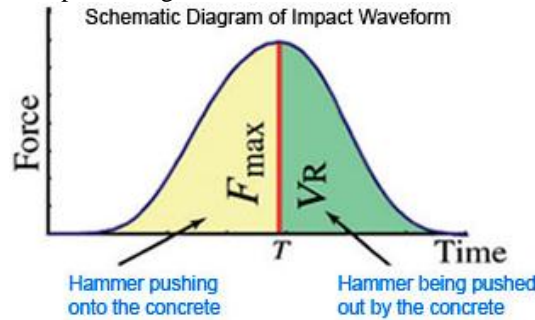
*ENR* reported (August 15, 2011) 289 units had been sold, mostly in Japan and Korea, and it sells for \$8,900 FOB Chicago through A-Lex International Marketing, Inverness, IL.



Tester apparatus and testing for strength, deterioration, and delamination



X represents points evaluated as poor using hammer. A PC can calculate hammer based strength contours



Schematic Diagrams showing general waveform and forms for strong and weaker/deteriorated concrete